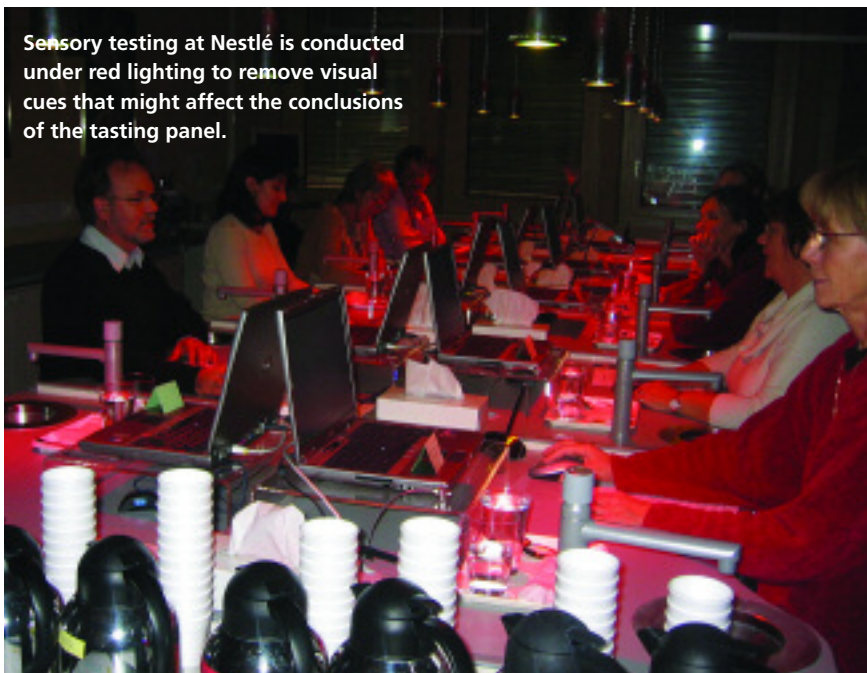


Sensory testing at Nestlé is conducted under red lighting to remove visual cues that might affect the conclusions of the tasting panel.



21ST CENTURY FOOD

While doctors are calling for a national audit of Australia's eating habits and nutritional needs, food companies are preparing for an era of "personalised nutrition" in which diet is matched to an individual's metabolism. Guy Nolch reports.

A National Nutrition Centre is needed to combat Australia's soaring obesity rates, according to a position statement released by the Australian Medical Association (AMA) in November. "Childhood obesity in Australia is rising at the rate of 1% each year, and over half of all young Australians will be overweight by 2025 unless parents, governments and the community address the problem together," says AMA President Dr Mukesh Haikerwal. "Overweight children are more than 50% more likely to become overweight adults, and our children are suffering from problems once thought to be diseases of middle age, such as heart disease, high blood pressure, liver disease and Type 2 diabetes."

Haikerwal said that \$10 million per year would be needed to fund the proposed National Nutrition Centre, which "would provide independent

policy advice to governments and also carry out surveys and research, public education campaigns and accreditation of weight loss programs".

The AMA's position paper recommended that:

- school canteens should not profit from selling junk food to children, and vending machines that stock anything but water should be banned in schools;
- the sale of chocolates and lollies as school fundraisers should be banned;
- all junk food advertising to children should be banned;
- food labels need to be more user-friendly;
- a comprehensive national nutrition survey is needed to map patterns of food consumption as current data is now 10 years old;
- a national accreditation system is needed to help identify evidence-

based weight loss programs; and

- food should be "fortified" to address micronutrient deficiencies, like folate and iodine, in the general population.

But food companies have already recognised the risks that rising obesity levels pose to consumer acceptance of their products. The "healthy choices" mantra is an obvious example of how McDonalds has stepped back from the "supersize me" culture it pursued relentlessly.

Likewise supermarket shelves are being transformed by 21st century foods that have less fat, sugar or salt and more "functional" components such as antioxidants and micronutrients. To achieve these aims, food companies from multinationals to family-owned enterprises are turning to science to get a lead on their competitors in the race to beat obesity and the many diseases it is associated with.

Personalised Nutrition

We are in the middle of an "explosion" of metabolic diseases, says Prof Ronald Khan of the Harvard Medical School. Speaking at the International Nutrition Symposium at the Nestlé Research Centre (NRC) in Lausanne, Switzerland, Khan said that by 2025 rates of Type 2 diabetes in the USA will be 59% higher than 1995 levels. Western Europe will similarly rise by 38%, with 27.9 million suffering the disease in 2025.

But the greatest rises are occurring in the developing world, with massive increases in the number of diabetics expected in South America (254%), Africa (290%), India (295%) and China (235%). At present almost 200 million people have diabetes but this is expected to rise to almost 333 million by the year 2025.

"Just when we all should be enjoying the greatest health in history, the majority of people in the Western world are becoming overweight and obese,"



Nestlé's headquarters in Switzerland devotes most of its top floor to an exhibition promoting the company's vision of becoming a "nutrition and wellness" company.



Bruce German of Nestlé says we will soon be able to obtain a profile of our metabolism from a simple urine test, paving the way to personalised nutrition.

says Dr Bruce German, Senior Scientific Officer at Nestlé, which had invited Khan and 150 experts in nutrition to share the latest research to address the impact of metabolic dysfunction on health, particularly the rising toll of obesity on metabolic diseases like diabetes.

This year's symposium was witnessed by an invitation-only list of 25 journalists from throughout the world. *Australasian Science* was the only representative from Australia or New Zealand.

Kahn's research into diabetes provides tangible proof of how single genetic changes can produce profound metabolic differences. His laboratory has developed "knock-out" mice in which a family of genes involved in the binding of insulin to cellular receptors are disrupted, producing different effects on glucose metabolism. The most intriguing of these is a strain of mouse that is lazy and eats more than other mice yet puts on less weight when fed a high-fat diet.

Khan's evidence supports our everyday observations of the people around us, from the skinny man who eats more than he wants in a futile

attempt to put on weight, to the women who complain that they will gain weight just by looking at chocolate.

While genetics plays a key role in determining our metabolic profile, and hence our predisposition to metabolic disease, lifestyle factors like exercise and diet are also important.

"Junk food" and unhealthy canteen inventories have been blamed for rising levels of obesity, but German says that fast food is not the sole cause of the obesity epidemic. "I cannot readily blame fast food," he says. "There are a lot of people who are overweight who don't eat fast food."

Instead German says other foods can be part of the problem. "For some people it's beer. It's easy to find a whipping boy like soft drinks and fast food. That's not the solution." Instead he says "portion sizes are to blame".

Regardless of whether genes or eating habits are the cause of rising obesity levels, German says there are "serious health problems" emerging from our expanding waistlines. "In the short-term, pharmaceuticals may be the most appropriate solution," he says, but "in the long-term it's probably not the optimal solution".

"It is extremely difficult once a metabolic disease like atherosclerosis or diabetes has developed to reverse it therapeutically. It's much better to prevent it, but how we do that is a great challenge.

"Food is probably going to be the most effective means to do that in the future. But in order to do that we have to know more about food and metabolism, but you're going to have to know more about yourself and take charge of your health status by knowing what are the types of foods and ingredients that are necessary for your optimal health."

German says that before this can occur "we're going to have to measure you" – and this may occur sooner rather than later. German says that current technologies can already measure hundreds of metabolites, and this could soon be refined so that we can all obtain a profile of our metabolism from a simple urine test. The development of such a test will usher

in an age of “personalised nutrition”.

Already Dr Laurent Fay’s laboratory at the NRC is trying to find biomarkers that can be used to predict metabolic health. He says that mass spectrometry of a urine sample could be used to produce a metabolic “fingerprint” that reveals a patient’s genotype, diet, disease state and even age. From this he says a doctor could determine a patient’s metabolic needs and adapt a diet to it. Fay’s “dream” is to produce a dipstick that could be used in the same way as home pregnancy tests.

Fay says that some people burn fat more rapidly than others, and a biomarker test for this could be used to design specific diets for each type. He says that a clinical trial that is examining metabolic biomarkers for fat metabolism should be completed in 2–3 years.

Of course, a metabolic make-over won’t be possible unless the food industry adopts the “wellness” mantra, but this paradigm shift is already underway. Christiane Kuehne, Head of Nestlé’s Corporate Wellness Unit, says that in the past 5 years more than 700 of Nestlé’s products “underwent nutri-

tional renovation”. Many now have reduced levels of fat (58% of products), calories (56%), sugar (25%), salt (11%) and cholesterol (15%), while others have been enriched in calcium (22%), fibre (11%), and vitamins, omega-3 or omega-6 fatty acids (27%).

In addition, Nestlé is incorporating functional foods wherever possible into its product range. For example, products branded with the “ActiCol” logo contain a plant sterol that inhibits cholesterol absorption in the intestine. Likewise Calci-N in Nesquik – a chocolate powder added to milk – improves the bioavailability of calcium, with trials revealing significantly higher mineral bone density in children after 1 year.

Other “branded active benefits” include probiotics, prebiotics, antioxidants, vitamins, minerals, fatty acids, fibre and even slow-release caffeine “for longer-lasting alertness”.

Current research by Dr Heribert Watzke is turning to molecular delivery systems to increase the bioavailability of these functional foods. For instance, he has been using the whey proteins in milk as a delivery system for the

antioxidant lycopene, which is found in tomatoes but is not readily absorbed by the gut.

And with diabetics becoming an increasingly important market segment it is not surprising that products will be targeted to their specific dietary needs. For instance, Dr Irène Corthésy’s laboratory at the NRC has incorporated β -glucan into muesli bars and wafers that diabetics will consume with their daily meals. β -glucan is a dietary fibre found in oat and barley that forms a viscous bolus in the presence of sugar. As a result, β -glucan can be used as a dietary supplement to limit the absorption of sugar and prevent a diabetic’s blood sugar levels from spiking after a meal. The product must go through regulatory approval before its initial launch in Asia.

Biofortification

Nestlé’s A\$1.5 billion research program may help the company to back the health claims made on the standardised “nutritional compass” on its labels, but even simple measures can produce significant health benefits.

Each year in Australia approxi-

CORPORATE WELLNESS

While Nestlé is best known for its chocolate, coffee and snack products, it is in the process of transforming itself “from a food company to a nutrition and wellness company based on science,” says Sean Murphy of Nestlé’s Corporate Wellness Unit. The lingo sounds clumsy but it is consistently repeated by the company’s scientists and managers and replicated by its competitors in the food industry, for which “healthy choices” are seen as the key to maintaining market share.

Nestlé is serious about food science, and redirects 1.6% of its A\$95 billion turnover – or A\$1.5 billion – back into R&D. In addition to 300 scientists working at the NRC, the “Nestlé world” brings together more than 3000 research collaborators, according to Christiane Kuehne, Head of the Corporate Wellness Unit.

Peter van Bladeren, the Director of the NRC, adds that in the past year Nestlé has produced 262 scientific publications and maintained 103 contracts with universities and start-up companies. “This is in addition to what we patent and what we keep secret,” he says.

Kuehne says that Nestlé is currently conducting 30 clinical trials worldwide. When these are completed the results will be analysed by its ethical committee before being submitted for approval by national regulatory bodies like the US Food and Drug Administration.

Nestlé’s R&D budget dwarfs Australia’s efforts in health and medical research. For example, the National Health and Medical Research Council allocates about \$450 million of federal government funding for medical research.

Likewise, a recently leaked report on CSIRO’s research priorities recommended that Australia’s premier research organisation restrict its health research “to preventative health, including the relationship between food with nutrition and healthier lives”. While CSIRO’s total research budget was approximately A\$630 million last financial year, its Preventative Health and Food Futures flagships receive only a fraction of the \$154 million allocated to CSIRO’s six Flagships. .

mately 500 babies are born with neural tube defects that lead to serious medical conditions like spina bifida. As an embryo grows, the neural tube develops into the spinal cord and brain. In the case of spina bifida, however, the spinal cord protrudes through a cleft in the spinal column, resulting in partial or even total paralysis of the lower body.

While little is known about the causes of neural tube defects, research has found that supplementing the diet with folic acid during the first 4 weeks of pregnancy can protect the developing foetus against diseases like spina bifida.

However, many women are not aware of their pregnancy during this time, so doctors recommend that all women of child-bearing age take a multivitamin containing folic acid. Since this campaign began in 1996, neural tube defects dropped in Western Australia from two children in every 1000 born to 1.3/1000. However, much of this decrease can be attributed to termination of pregnancies after scans have revealed foetal abnormalities.

In an editorial in the *Medical Journal of Australia* on 2 October, Prof Fiona Stanley of the Telethon Institute for Child Health Research in Perth and Prof Glen Maberly of Emory University, USA, argued for mandatory fortification of flour with folic acid. Mandatory fortification has yet to be introduced in Australia despite the recommendation of the National Health and Medical Research Council.

The Australian, New Zealand and UK governments are considering mandatory fortification of flour with folic acid. Their decisions are expected in the first quarter of 2006.

Already more than 40 countries have approved fortification of flour with folic acid, and the number of neural tube defects has dropped by 30% in the USA, 50% in Canada and 70% in Chile since fortification of flour with folic acid was made mandatory in 1996. "Since



Prof Fiona Stanley questions why fortification of flour with folic acid isn't mandatory in Australia.

mandatory flour fortification with folic acid in the US, there have been 17,000 fewer heart attacks and 31,000 fewer strokes," Stanley and Maberly wrote. "In addition, several recent scientific articles have credited folic acid supplementation with protection against loss of cognitive function in the elderly and Alzheimer's disease, and against several cancers (including neuroblastomas)".

Stanley's key role in an international collaboration that established the importance of folic acid in the prevention of spina bifida earned her the title of Australian of the Year in 2003.

While folate is associated with a reduced risk of spina bifida, heart attack and stroke, it may also mask pernicious anaemia (the result of vitamin B12 deficiency) in older people and is associated with an increase in certain cancers. However, there is no link between folate and vitamin B12 deficiencies, and evidence points to an overall reduction in cancer risk.

"If there were a toxin (such as lead and mercury) or an infectious agent (such as the mad cow product) in the nation's food supply, action would be swift and decisive," Stanley and Maberly wrote. "The ethical issue here is not what harm the mandatory forti-

fication of flour with folic acid would do; rather, it is the harm inflicted each day that fortification is delayed by those who know how to prevent the damage from folic acid deficiency."

Stanley and Maberly estimate that folic acid fortification would cost 20¢ per tonne of flour – a small price to pay given that the lifetime cost of spina bifida is US\$500,000.

Our Daily Bread

Flour is also at the centre of biofortification efforts involving the important micronutrient selenium. Dr Graham Lyons of the University of Adelaide's School of Agriculture and Wine says that selenium is an important antioxidant with a long list of health benefits. It is associated with reduced rates of heart disease, cancer, viral infection, infertility, heavy metal toxicity, pancreatitis, asthma, arthritis, cystic fibrosis, muscular dystrophy, and even DNA damage and ageing. In addition, low levels of selenium are associated with cognitive impairment, depression, anxiety and hostility while selenium supplementation can improve brain function, including some forms of epilepsy.

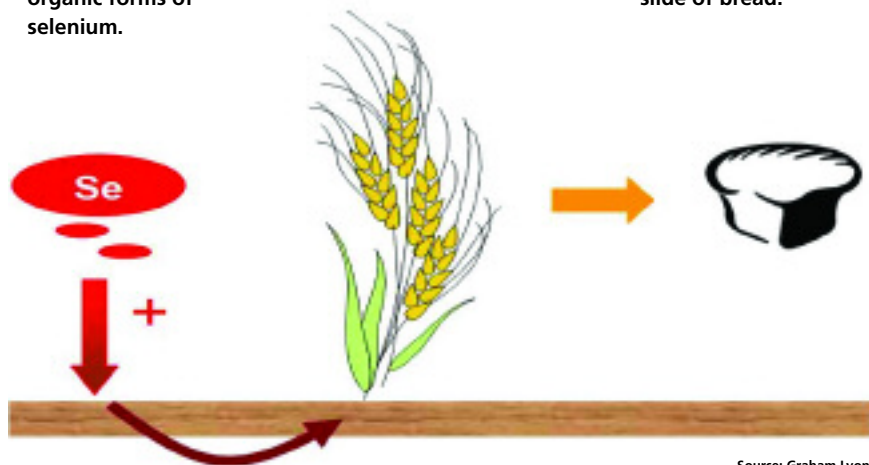
Lyons rattles of a number of studies that reveal selenium's widespread health benefits.

- **DNA damage:** a New Zealand clinical trial found that selenium-deficient men had greater DNA damage in lymphocytes, but supplementation of 200 µg selenium normalised this. A Polish study found that a 300 µg/day supplement selenium reduced chromosome breaks to normal levels in women with the breast cancer gene mutation *BRCA-1*. Furthermore, selenium helps to maintain the length of telomeres, which defines how many times chromosomes can replicate during cell division.
- **Anti-ageing:** as a powerful antioxidant, selenium reduces free radical damage, which can accelerate

Selenium levels are increased in the soil. Soil-borne organisms initiate conversion to organic forms of selenium.

Plants naturally absorb extra selenium, with full conversion to organic forms.

Grains are harvested, milled and baked, with the optimum amount of selenium in each slice of bread.



Source: Graham Lyons

ageing. Lyons says that the cell's energy generators, the mitochondria, "churn out free radicals". Mitochondrial damage has the biggest effect on ageing, and hence old people "run out of energy" as their mitochondrial numbers diminish. However, selenium's antioxidant properties reduce mitochondrial damage, with selenium associated with reduced mortality in the elderly.

- **Anti-viral:** selenium deficiency is associated with suppression of the immune system, with a UK study revealing more rapid clearance of attenuated live polio virus. Furthermore, RNA viruses like influenza, measles, HIV and hepatitis are more unstable and likely to mutate to more virulent forms, with a US study finding that selenium-deficient patients are 20 times more likely to die from HIV-related causes. There is even speculation that Africa's selenium-deficient soils may be the reason why HIV has spread much faster there.
- **Anti-cancer:** selenium may induce the death of cancer cells and also reduce the development of blood vessels that enable tumours to grow. In the US Nutritional Prevention of Cancer Trial of 1312 people, 200 µg Se/day reduced total cancer

mortality by 41%, total cancer incidence by 25% and prostate cancer incidence by 52%.

However, Lyons says that there is "less selenium in the Earth's crust than gold", and it is rarer in some parts than others. For instance, selenium deficiency in some parts of China is associated with Keshen disease, which impairs cardiac function.

In Australia, areas at risk of selenium deficiency include the coastal regions of Queensland and NSW, the south-west coast of Western Australia, Tasmania, South Australia's Mount Lofty Ranges and Kangaroo Island.

But adequate selenium levels in the soil do not guarantee that selenium will be taken up by plants. Selenium is relatively unavailable to plants in soils that are acidic and poorly aerated. Selenium also binds to iron in the soil to form largely insoluble complexes, and can also be leached from soil in wetter areas, including those under irrigation. Lyons adds that intensive agriculture may also strip soils of selenium, while agricultural practices such as liming also reduce selenium uptake.

The recommended dietary intake (RDI) of selenium is 85 µg/day for men and 70 µg/day for women, but Lyons says this is much too low. Rather, men should be consuming 230 µg/day and

women 130 µg/day. Furthermore, smokers need more of this antioxidant as "each puff has 10¹⁴ free radicals".

However, Lyons' research has found that South Australians aren't getting sufficient selenium in their diet. He has found that selenium levels in blood samples taken from South Australian residents from 1977 to 1988 dropped by 20% before steadying. At the end of the study in 2002, blood concentrations averaged 103 µg/L – barely above the estimated nutritional adequacy level of 100 µg/L.

While selenium is available in a multivitamin supplement, Lyons says that organic forms of selenium are used by our bodies more efficiently than inorganic forms found in vitamin pills. He says he has been taking a selenium-enriched yeast supplement for 7 years and proclaims: "I am jumping out of my skin".

But yeast extracts aren't for everyone, which is why Lyons has been biofortifying wheat crops with selenium. Of the cereal crops, wheat is the most efficient accumulator of selenium. Furthermore, bread is an important staple food and already supplies one-third of the daily selenium intake of Australian children. Add to that the selenium supplied through breakfast cereals, cakes and biscuits, and wheat probably supplies one-half of our dietary selenium.

The use of selenium as a crop fertiliser has been mandatory in Finland since 1984, with dietary intakes there trebling and blood concentrations nearly doubling in the first 3 years. In New Zealand, sodium selenate is applied to pastures to increase selenium uptake by livestock and therefore increase selenium levels in meat and milk.

Lyons has now developed a fertilisation method that can increase the selenium concentration in the grain of wheat 100-fold. Selenium, which is a by-product of copper mining, is applied to the wheat crop at the flowering

stage, and becomes incorporated throughout the grain. "Wheat converts the inorganic selenium to a form which is particularly suitable to humans," he said.

He says that a recently completed 6-month trial comparing levels of selenium in the blood of 75 men found that selenium bioavailability was "a lot better" among those who ate biofortified wafers compared with those eating process-fortified wafers or a placebo.

Laucke Flour has begun milling flour biofortified with selenium, which it launched in September in conjunction with Country Life Bakery's bioMAX brand of selenium-enriched bread. Each slice of the bread contains 25 µg of selenium. Lyons recommends two slices per day for women and five slices per men to reach their optimum selenium intake.

While selenium can be toxic if supplementation exceeds 400 µg/day for adults and 280 µg/day for children, Lyons believes these concerns are overplayed as selenium intake can easily be reduced. Nevertheless he says: "One slice of Biomax/day wouldn't hurt any [small] children... but I wouldn't recommend more than this."

Healthy Chocolate

But "man cannot live on bread alone", which is why chocolate is such a popular food throughout the world. While high levels of saturated fats and sugar in chocolate aren't helping the world's obesity and diabetes problems, new research is finding that chocolate

consumption, in moderation, can be good for you.

Dark chocolate is rich in antioxidants that lower the levels of free radicals in the blood. Prolonged and high-level exposure to free radicals has been linked to cardiovascular disease and some cancers, but catechins derived from cocoa beans can mop up these free radicals. Catechins are also found in fruit and tea, but our bodies need different types of catechins, such as those found in chocolate and tea. Furthermore, chocolate contains higher levels of antioxidants than tea.

Chocolate is big business, so manufacturers are going to great lengths to make chocolate "healthier", or at least enable them to claim it is healthier. Enter the food scientists.

In Japan, Nestlé has boosted the antioxidant levels of its Kit Kat range by introducing red wine and green tea varieties of its most popular product.

And in October its rival Mars launched the "healthy" CocoaVia bar into the health food section of US grocery stores and chemists with the tagline "Be Good to Your Heart Every Day". Ingredients in the CocoaVia range "can significantly reduce LDL cholesterol levels," according to a Mars media release. The range contains a "blend of heart-healthy cocoa flavanols and cholesterol-lowering plant sterols from soy. The new line of snacks is also fortified with calcium and a mix of heart-healthy nutrients including folic acid, vitamins B6, B12, C and E."

There is evidence that flavanols help

the circulatory system by reducing the oxidation of LDL cholesterol, which is associated with clogging of the arteries. While flavanols are found naturally in cocoa beans, traditional cocoa processing often destroys many of these potentially heart-healthy compounds. However, Mars has patented a process that ensures that the flavanols found naturally in cocoa are not destroyed and remain at a consistent level.

Mars cites research conducted at the University of California-Davis which found that two servings of CocoaVia snack bars significantly lowered total and LDL cholesterol levels without impacting on HDL or "good" cholesterol.

With benefits like this, consumers no longer need to feel guilty about their chocolate addiction. Indeed we should make it a regular part of our diet, according to Prof Kristine Clark of Pennsylvania State University who said: "When eaten everyday, CocoaVia can help contribute to a heart-healthy lifestyle".

But we won't need to eat more chocolate, according to Mars: "Since each serving is packed with the heart-healthy flavanols, you can eat a relatively small portion and still reap the benefits. That means less fat and fewer calories compared to a regular, larger-sized chocolate bar."

But who would eat less when it's so good for you?

Guy Nolch was a guest of Nestlé at the International Nutrition Symposium in Lausanne.



ISSUES

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DIET & HEALTH

Science has provided us with a range and quantity of food unthinkable to even our most privileged ancestors. However, we are also seeing widespread concerns about issues such as rising obesity and genetically modified foods. **ISSUES 72** looks at these debates, as well as new developments in food technology and the question of whether chocolate really is good for you. See page 7 for subscription details or order your copy of this edition at

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